



Neuroscience Module

Lecture (7)

Role of amino acids derivatives in CNS metabolism

By

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Lecture Key points



- The metabolism and clinical significance of important compounds derived from amino acids

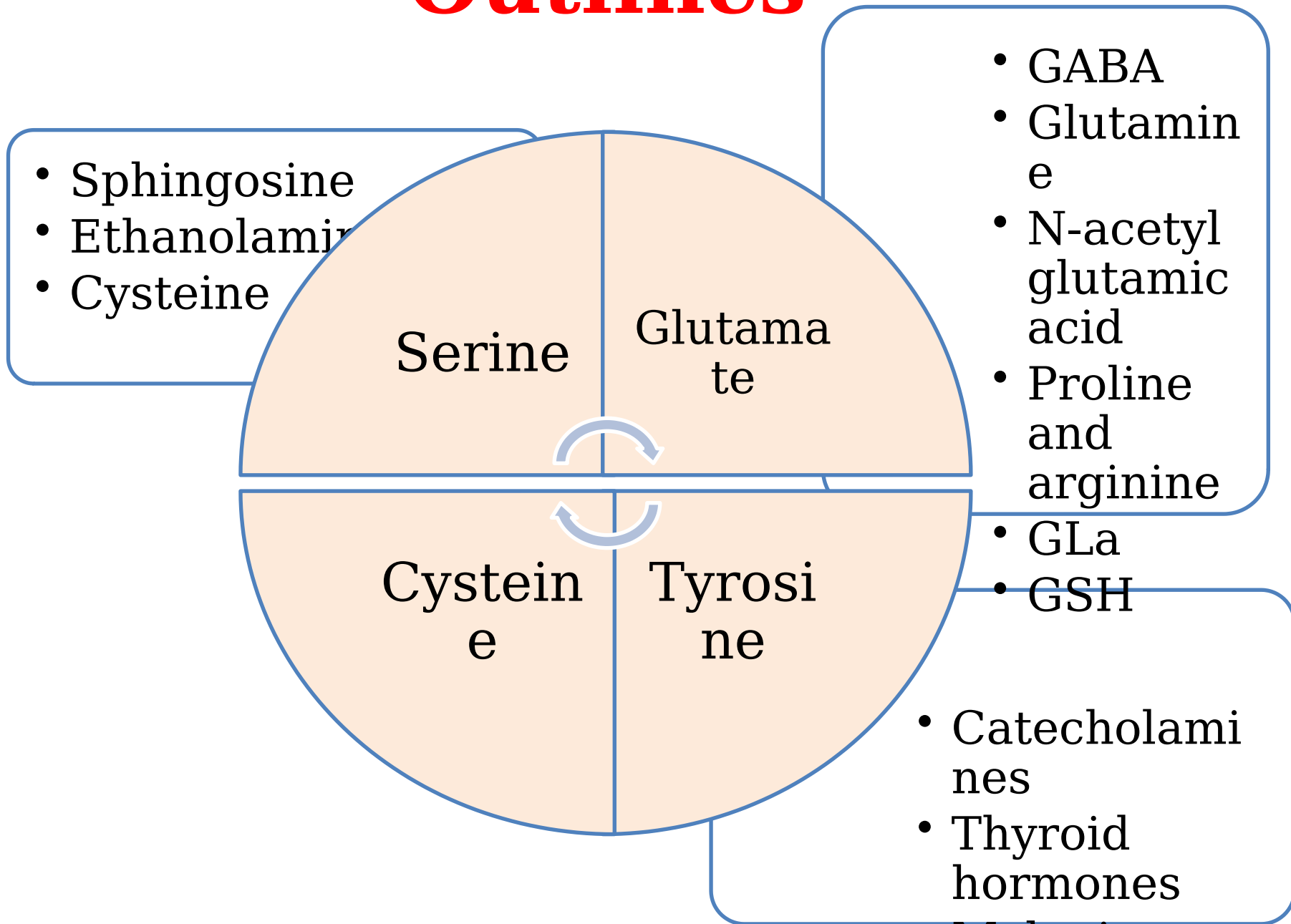
INTENDED LEARNING OBJECTIVES (ILO)



By the end of this lecture the student will be able to:

1. Categorize compounds derived from amino acids
2. Explain with illustration the synthesis and degradation of important compounds derived from amino acids
3. Discuss clinical importance of compounds derived from amino acid metabolism

Outlines



Amino acids

Amino Acid Requirements of Humans

Nutritionally Essential

Arginine^a
Histidine
Isoleucine
Leucine
Lysine
Methionine
Phenylalanine
Threonine
Tryptophan
Valine

Nutritionally Nonessential

Alanine
Asparagine
Aspartate
Cysteine
Glutamate
Glutamine
Glycine
Proline
Serine
Tyrosine

^a “Nutritionally semiessential.” Synthesized at rates inadequate to support growth of children.

Synthesis of non-essential amino acids

1)

- **From α -keto acids: By transamination**

2)

- **Synthesis of glutamine and asparagine: By amidation**

3)

- **Proline and arginine: From glutamate**

4)

- **Serine: From 3-phosphoglycerate and glycine**

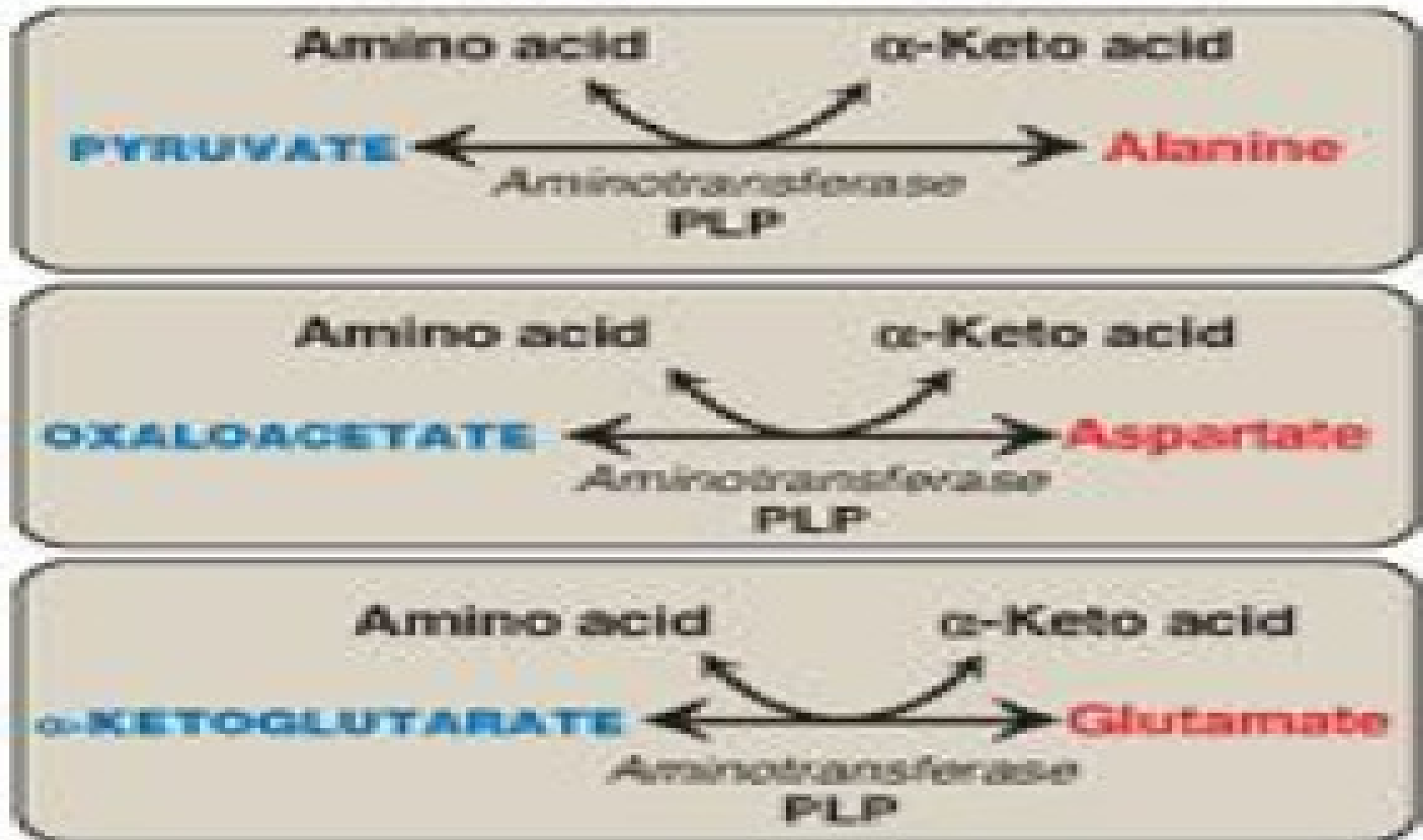
5)

- **Cysteine**

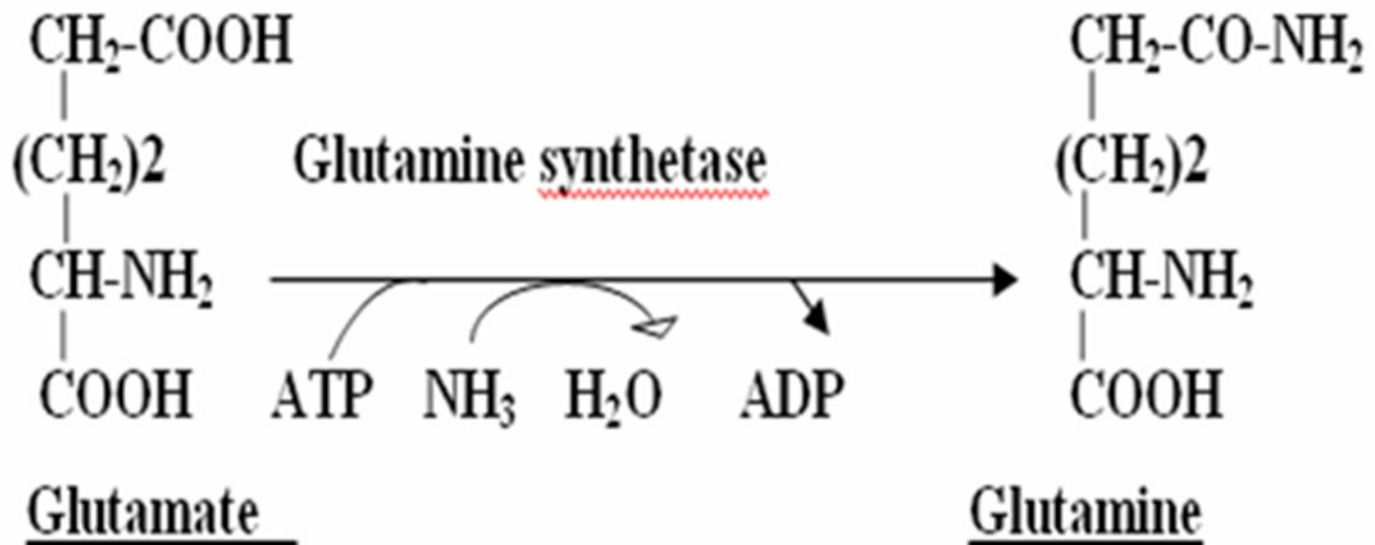
6)

- **Tyrosine: From phenyl alanine**

Synthesis of non-essential amino acids
1) By transamination (From α -keto acids):
Glutamate, aspartate and alanine



Synthesis of non-essential amino acids
2) By amidation: glutamine and asparagine

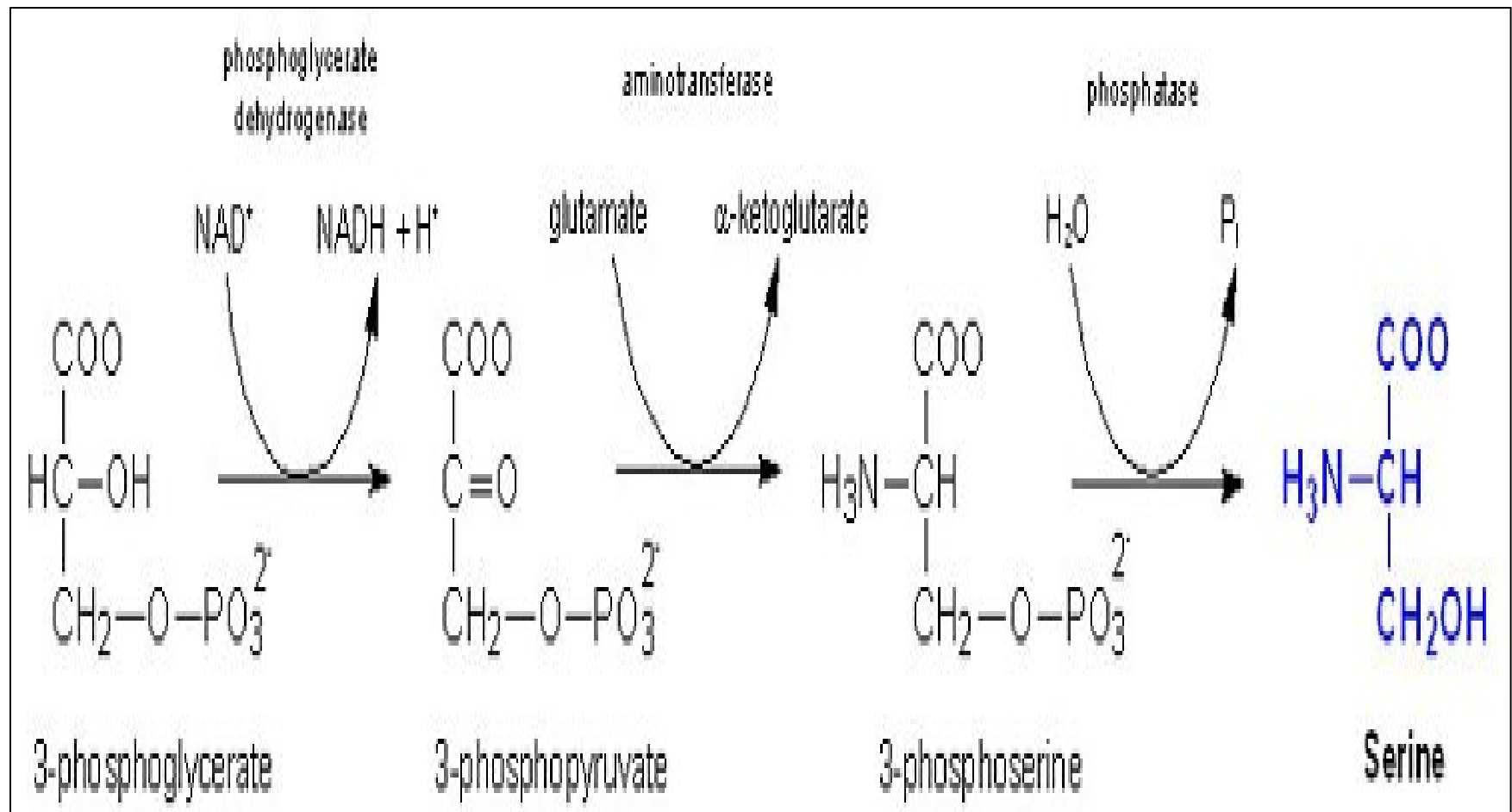


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Synthesis of non-essential amino acids

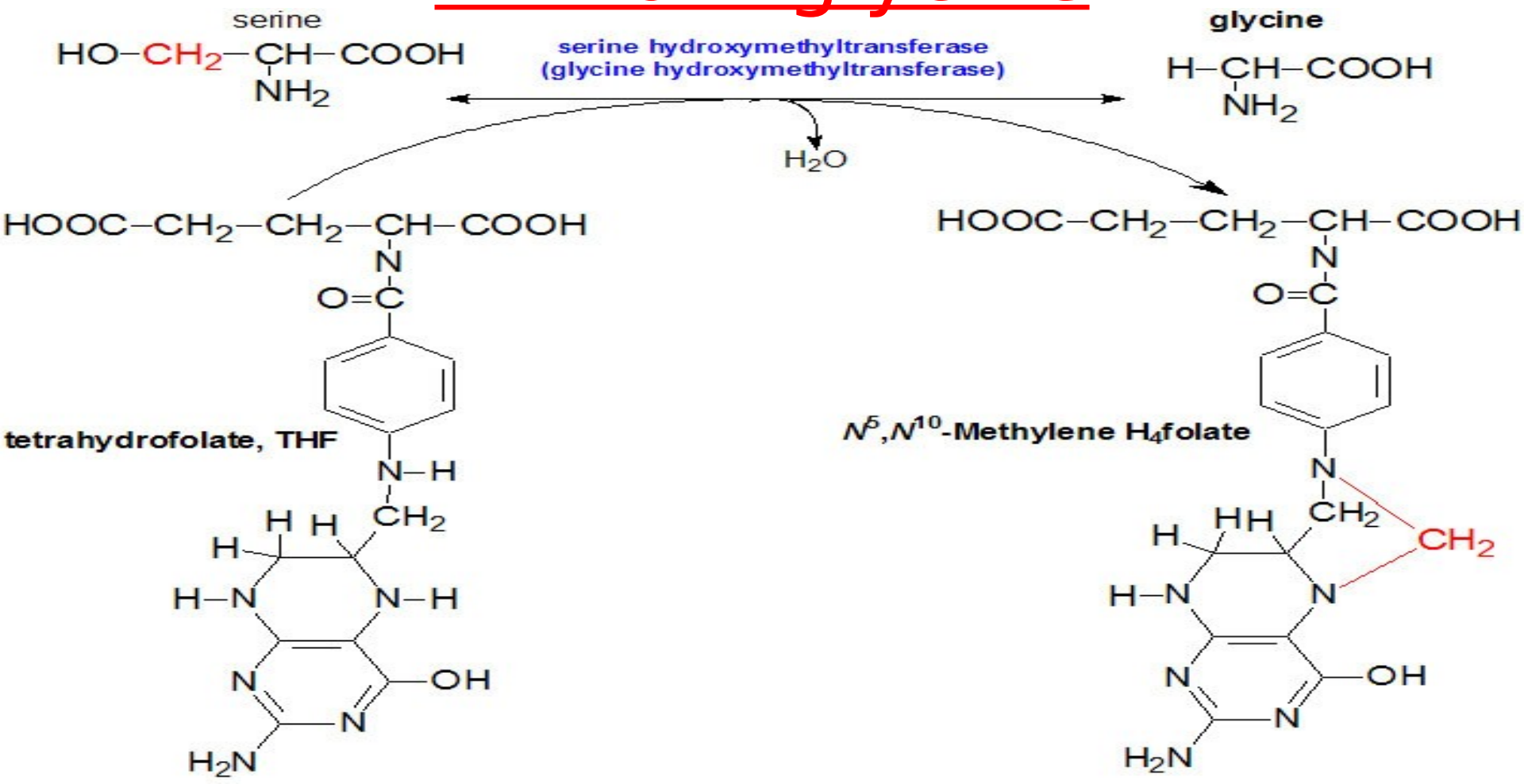
3) Biosynthesis of Serine

A) From 3-Phosphoglycerate (major source of serine)



Synthesis of non-essential amino acids

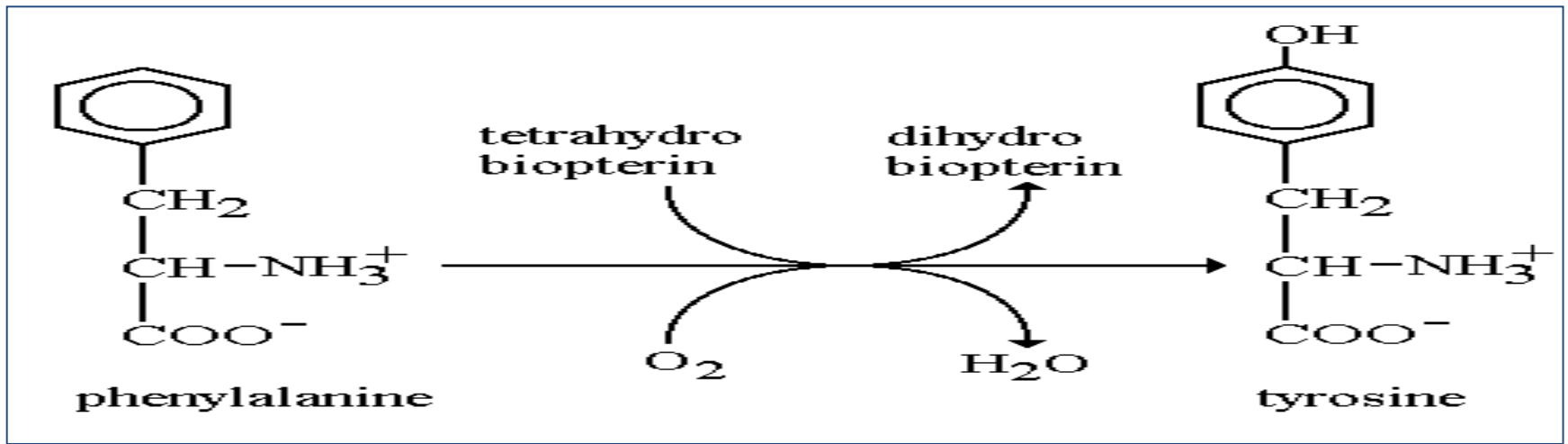
3) Biosynthesis of Serine B- From glycine



Synthesis of non-essential amino acids

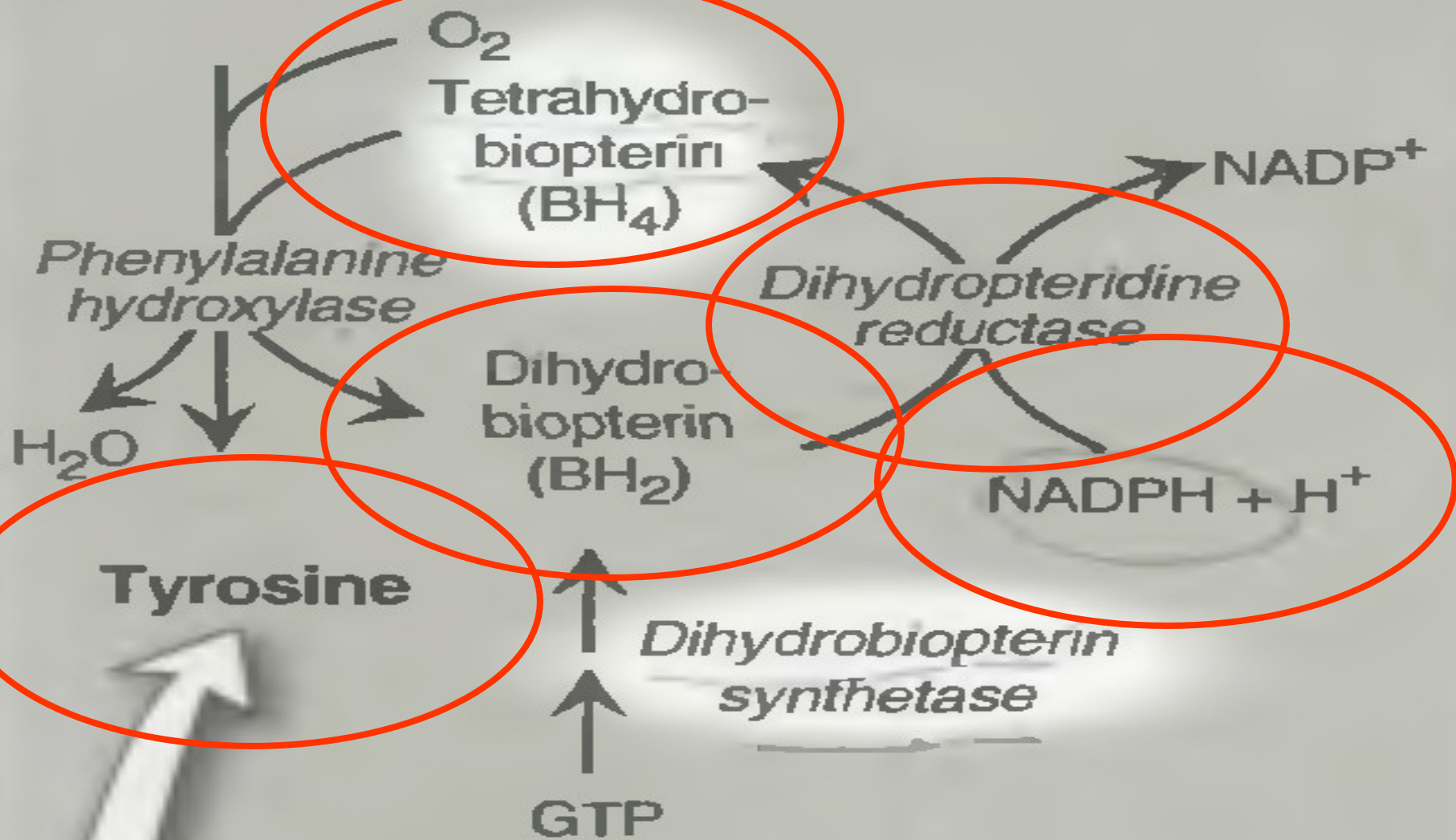
4) Biosynthesis of tyrosine from phenylalanine

Catalyzed by the enzyme
phenylalanine hydroxylase.



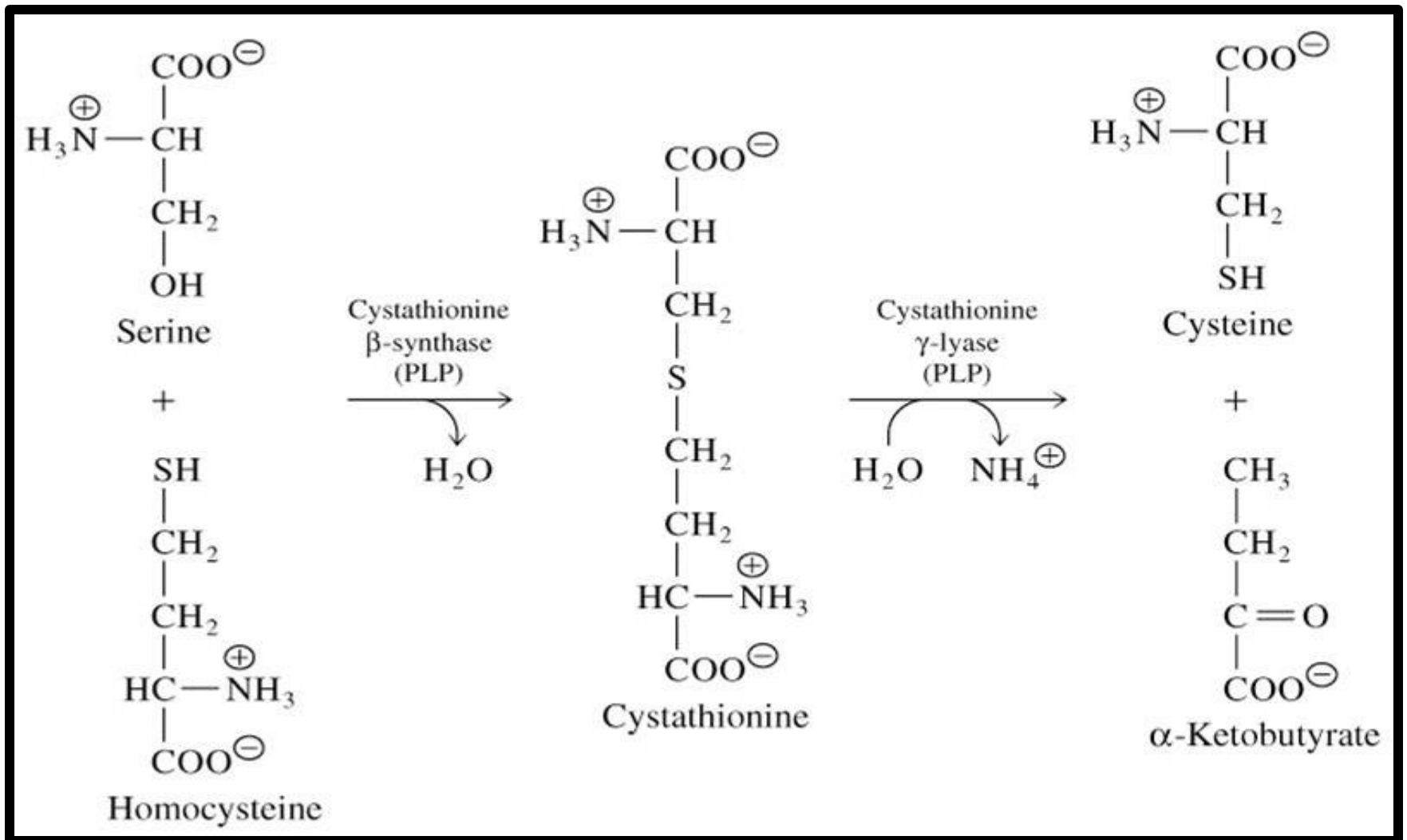
Tyrosine synthesis

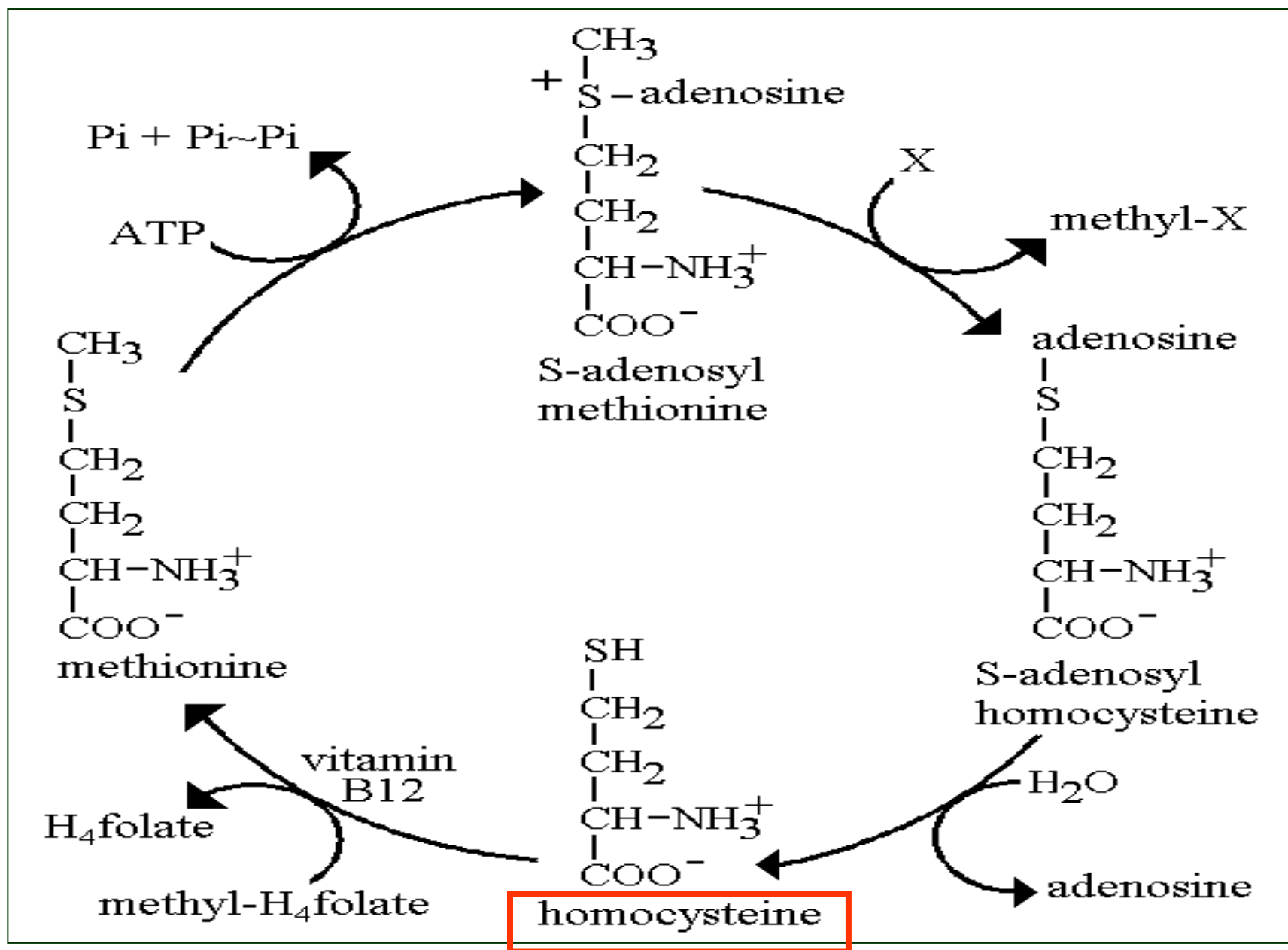
Phenylalanine



Synthesis of non-essential amino acids

5) Biosynthesis of cysteine from serine



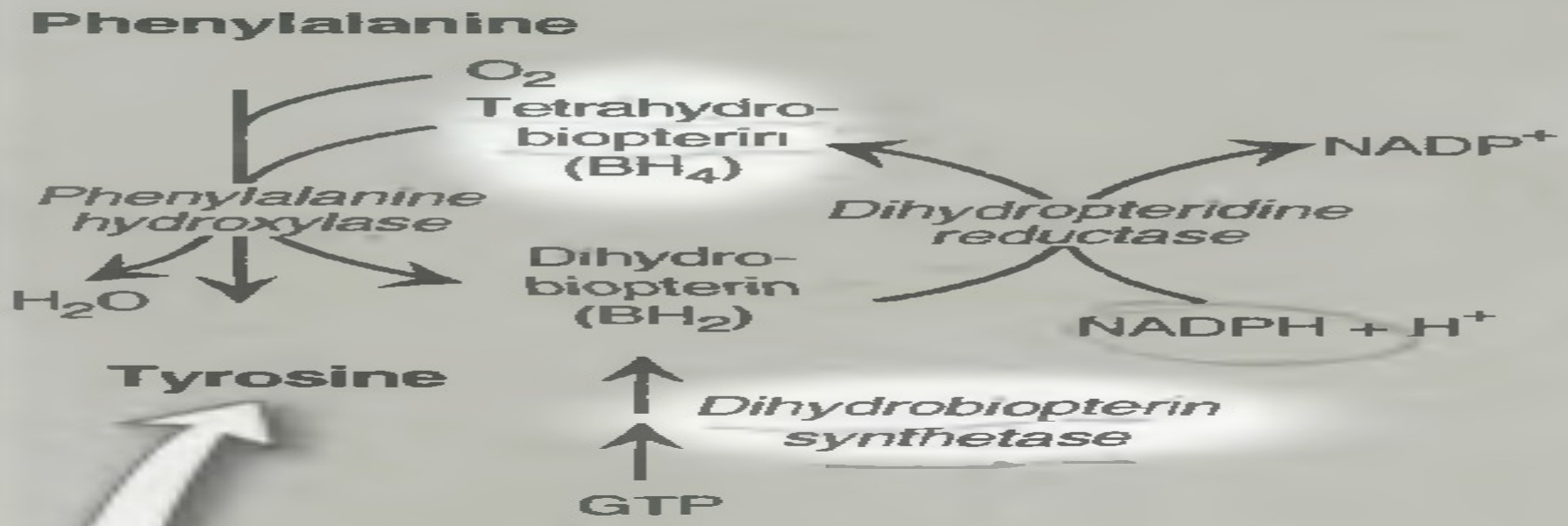


The metabolism and clinical significance of important compounds derived from amino acids (Quiz)



- Illustrate the synthesis of tyrosine from phenylalanine

Tyrosine synthesis



Biological compounds derived from amino acids

1) Serine:

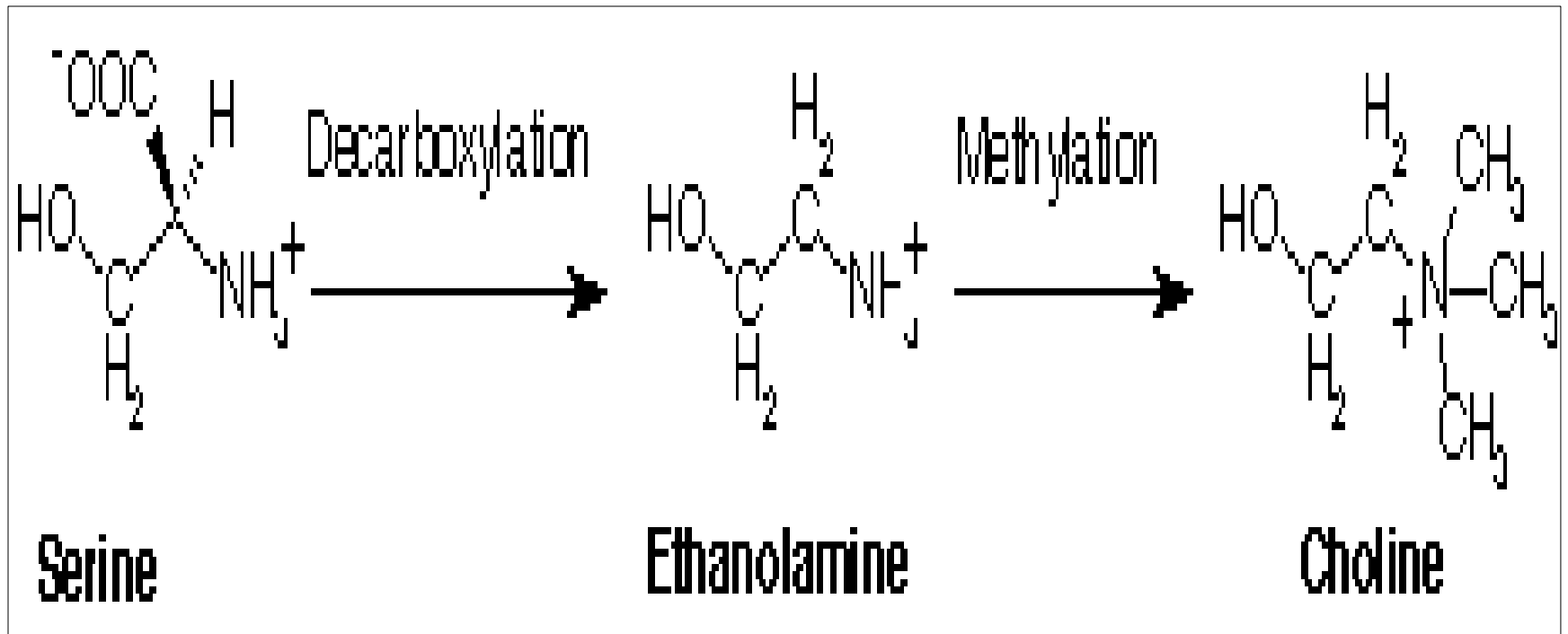
Sphingosine synthesis

**Serine
biological
importance**

Ethanolamine synthesis

Cysteine synthesis

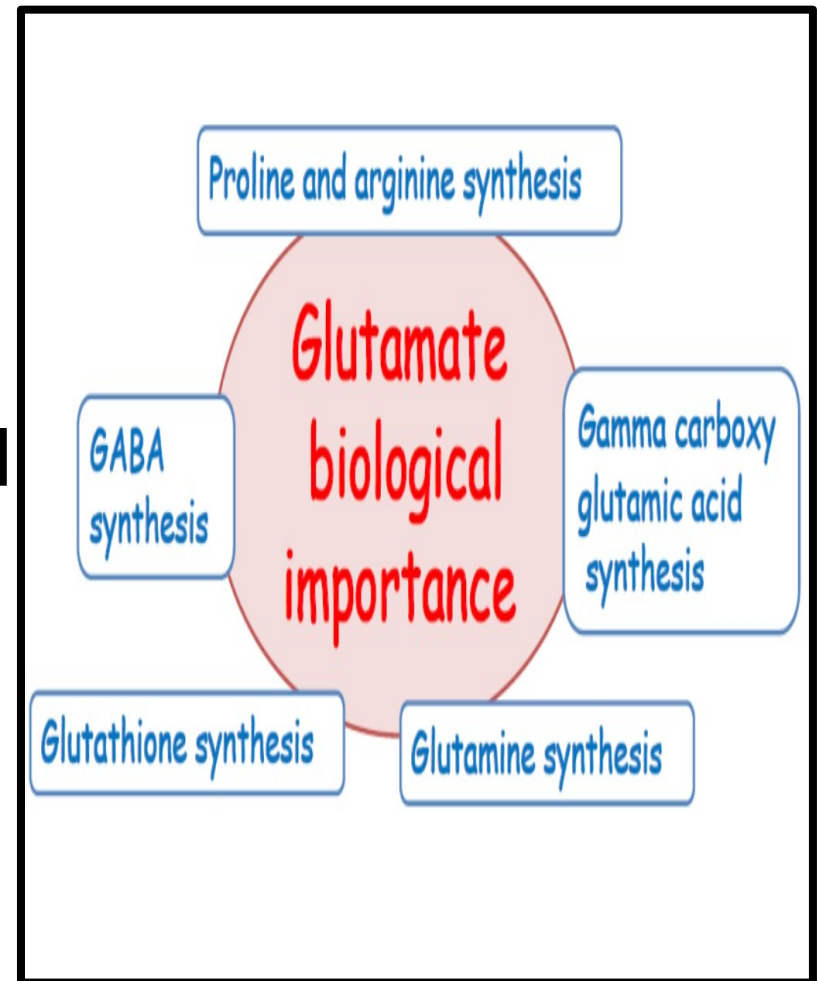
Ethanolamine



Biological compounds derived from amino acids

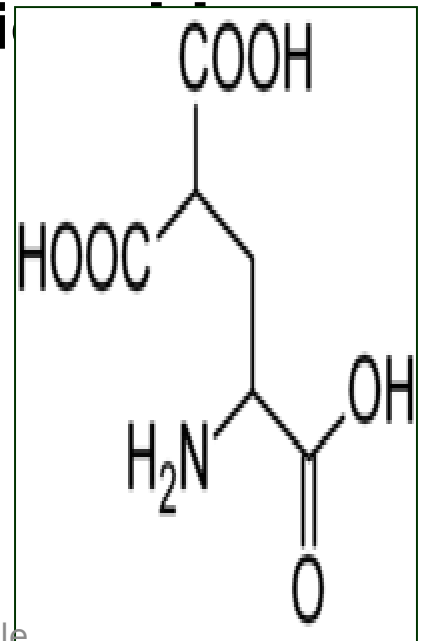
2) Glutamate:

- GABA (Refer to neurotransmitters)
- Glutamine
- N-acetyl glutamic acid
- Proline and arginine
- Gamma carboxyglutamic acid
- Glutathione



Gamma carboxyglutamic acid

- It is a glutamic with 2 COOH at its radical.
- Formed by carboxylation of glutamic at the γ -carbon on several calcium-dependent proteins (clotting factors II, VII, IX, and X and the anticoagulant proteins protein C and protein S) forming γ -carboxyglutami
- This process is vitamin K dependent.
- γ -carboxyglutamic acid chelates calcium ions which permits the binding of the blood-clotting proteins to membranes.



Biological compounds derived from amino acids

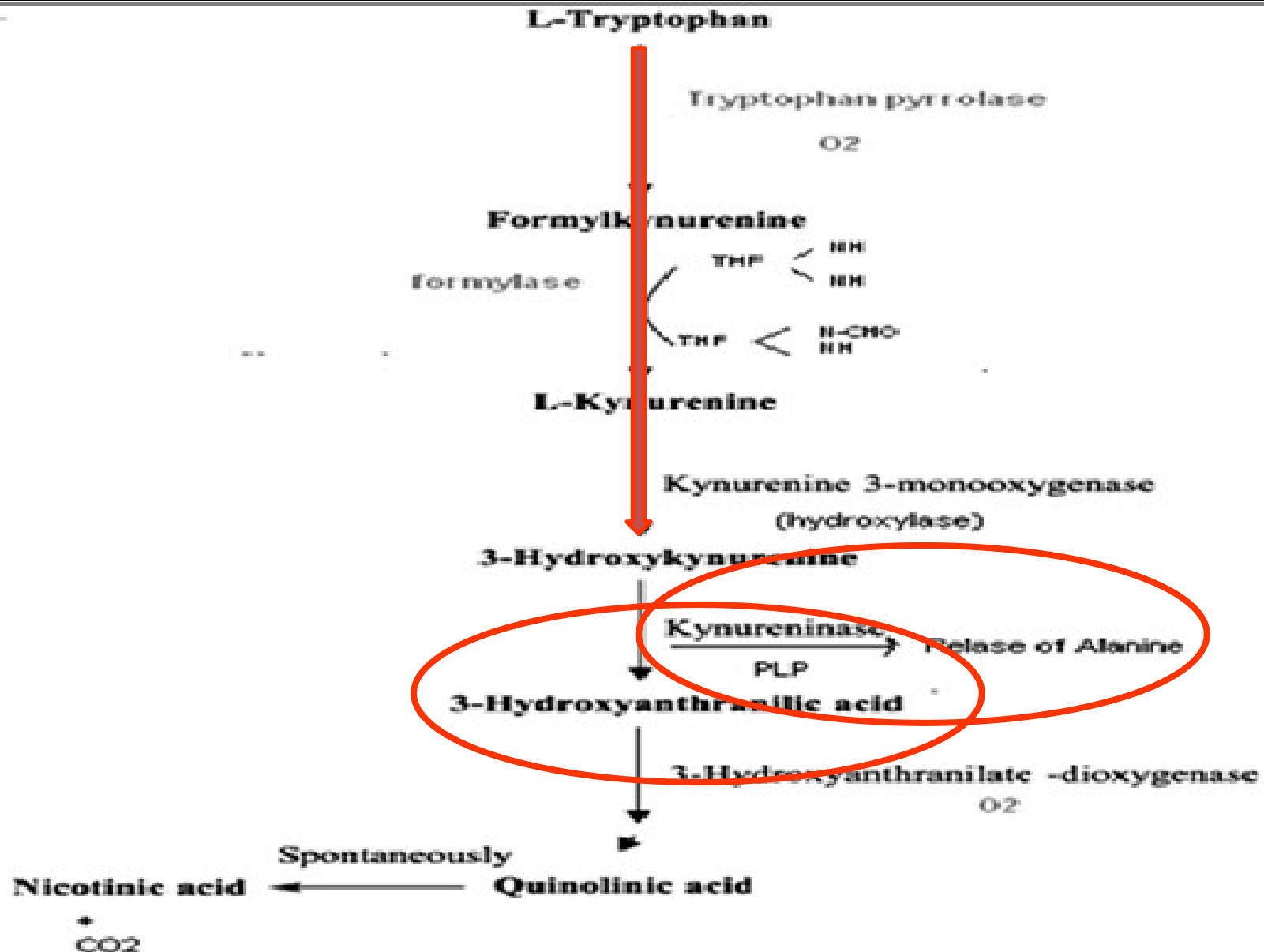
3) Tryptophan:

- Serotonin and melatonin
(Refer to neurotransmitters)
- Nicotinic acid

Nicotinic acid

- The major metabolic fate of tryptophan in the body is to be **oxidized** by **tryptophan pyrrolase**
- Tryptophan pyrrolase is a **heme protein**, induced by corticosteroids and increase tryptophan in diet.

Biosynthesis of nicotinic acid (NIACIN)

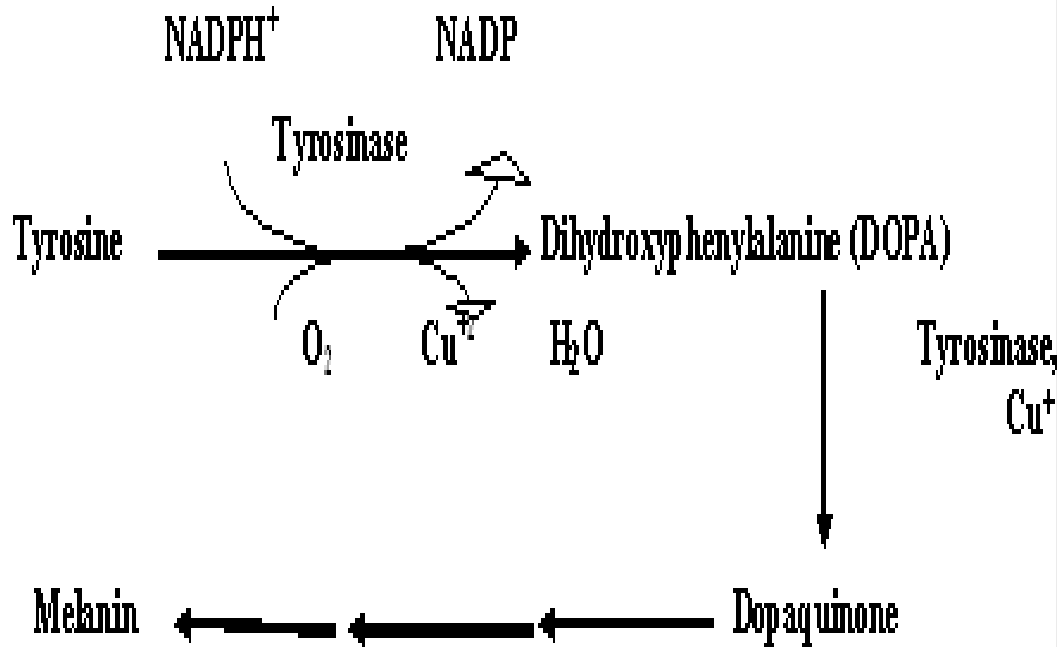


Biological compounds derived from amino acids

4) Phenylalanine and tyrosine:

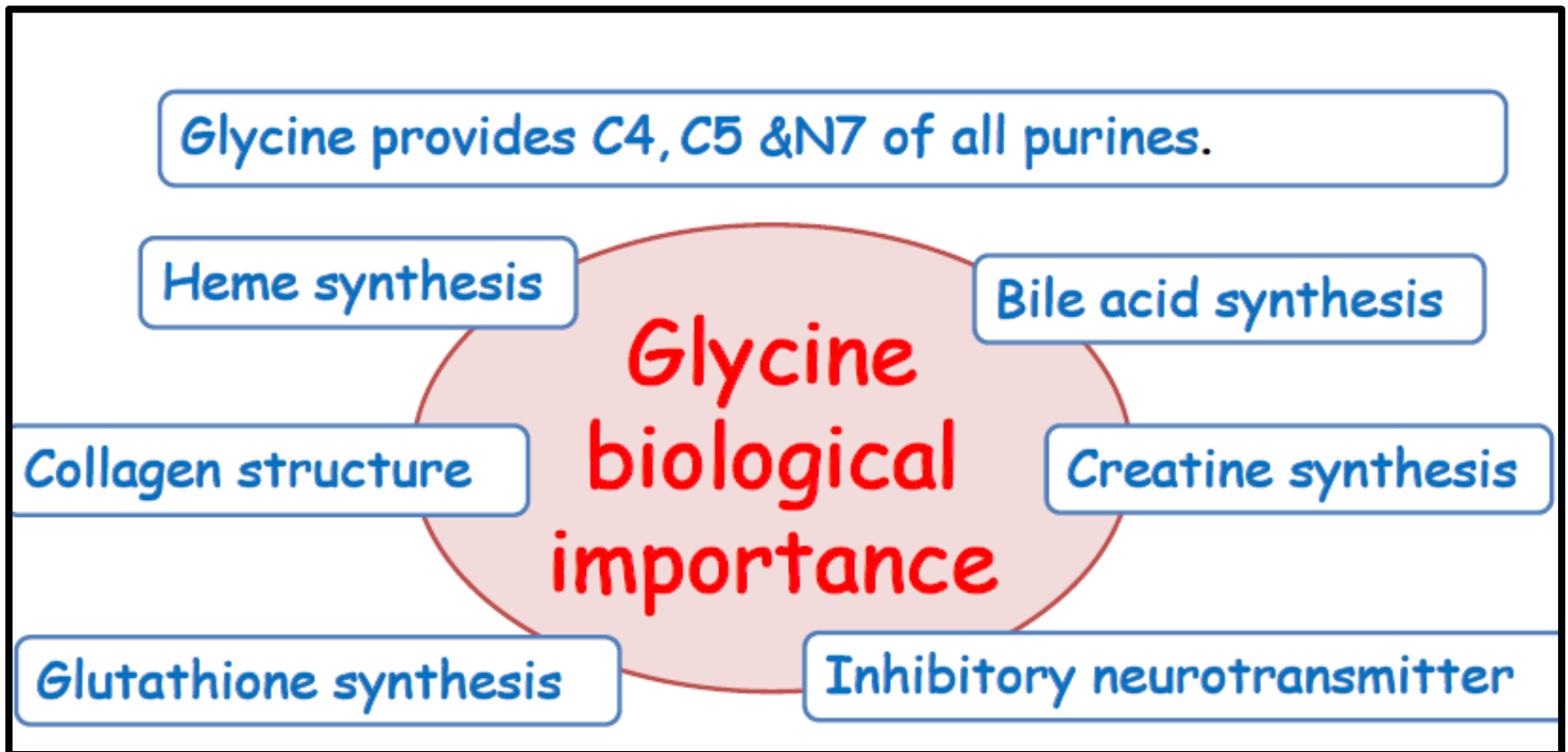
- Catecholamines (Refer to neurotransmitters)
- Thyroid hormones (Refer to T3 and T4 synthesis)
- Melanin

Synthesis of Melanin pigment in (melanocytes)



Biological compounds derived from amino acids

5) Glycine:



Lecture Quiz

USMLE Question

A 62-year-old woman presents to the clinic complaining of frequent bleeding while brushing her teeth and easy bruising. She reports she recently had pneumonia and was treated with a broad-spectrum antibiotic. Laboratory tests show:

Prothrombin time: 18 seconds

Partial thromboplastin time: 37 seconds

Platelet count: $231,000/\text{mm}^3$

Hematocrit: 37%

WBC count: $4800/\text{mm}^3$

The cofactor that is deficient in this patient is needed for the carboxylation of glutamate residues of which of the following?

(A) Factors II, VII, VIII, and X

(B) Factors VII, VIII, IX, and XII

(C) Proteins C and S and factors IX, X, XI, and XII

(D) Proteins C and S and factors XII, IX, and X

(E) Proteins C and S, prothrombin, and factors VII, IX, and X

Summary

- Nutritionally essential and non-essential amino acids
- Synthesis of non-essential amino acids
- The clinical significance of important compounds derived from amino acids

SUGGESTED TEXTBOOKS



- **Lippincott's illustrated reviews in Biochemistry by P.C. Champe, R.A. Harvey and D.R. Ferrier**
- **Fundamentals of Clinical Chemistry (Tietz)**
- **"Textbook of Biochemistry with Clinical Correlations" by T.M. Devlin**
- **"Harper's Biochemistry" by R.K. Murray, D.K. Granner, P.A. Mayes and V.W. Rodwell**

A close-up photograph of a bouquet of red roses. The roses are in various stages of bloom, showing detailed petal textures. Green leaves are interspersed among the flowers. A white rectangular box with a thin black border is centered over the middle of the bouquet.

THANK YOU